Rennick-Egglestone, Stefan and Brundell, Patrick and Koleva, Boriana and Roussou, Maria and Chaffardon, Christophe and Benford, Steve (2016) Families and mobile devices in museums: designing for integrated experiences. Journal on Computing and Cultural Heritage, 9 (2). 11/1-11/13. ISSN 1556-4673

Families and mobile devices in museums: designing for integrated experiences

S. RENNICK-EGGLESTONE, P. BRUNDELL, B. KOLEVA, S. BENFORD University of Nottingham

M. ROUSSOU University of Athens

C. CHAFFARDON Cité de l'Espace

This paper presents an observational study of eight families engaging with a bespoke tablet experience produced for a space science centre. It documents the various ways in which family members orientate themselves to the usage of technology in this environment, with a particular focus on the work done to manage the tablet and facilitate the engagement of younger children with the narrative of the experience. These findings are considered in the broader context of the need to design experiences that cater for engagement by families as a whole. We conclude by motivating the need for technologies that are robust in light of regular disengagement and by family members, and which provide functionality to directly support facilitation work.

• **Human-Centred Computing→User studies**

Additional Key Words and Phrases: Mobile experience design, museum studies, facilitation work

1. INTRODUCTION

Family groups are an essential element of the visitor base of many museums [Cone and Kendall 1978, Ellenbogen 2002], and as mobile devices and other digital technologies become increasingly integrated into the visiting experience, the needs of families will be an important consideration for technology design. Whilst many existing mobile visitor experiences target usage by individual visitors, members of a family group will often explore a museum together [Falk and Dierking 2009], and prior work has considered the value of designing experiences that coherently integrate interactions by multiple members of a family [Asai, Sugimoto and Billinghurst 2010], and also motivated the design of experiences for usage by "intact social groups" [Simon 2010]. How best to design for integrated family experiences is an open question, and might be informed by studies of how families behave in museums [e.g. see Tolmie et al 2013], and of how family members orientate themselves to the usage of technology in this environment. This paper engages with the latter by presenting a study of a technology deployment in Cité de l'Espace (CITE), a science education center in Toulouse, France. This deployment utilized a bespoke tablet app produced specifically for CITE as part of CHESS (Cultural Heritage Experiences through Socio-personal Interactions and Storytelling), a collaboration between technology researchers and museum practitioners. To understand how recruited families orientated themselves around a tablet, we conducted a naturalistic observational study of family interactions with the app, which took place during the course of a day-long visit to the site.

In presenting our findings, we focus on two topics of critical concern to the design of effective digital experiences in this context, namely how tablets are collectively managed by families as a visiting resource, and how older members of a group work to facilitate younger members. Engaging with a tablet in a museum is inherently a situated experience, and hence we have also considered

interactions between our families, the site and other visitors who are exploring the site concurrently. Collectively, our observations provide evidence for a substantial variation in management behaviors across families, suggesting the adoption of a flexible experience design which does not assume or impose a single model of sharing. We also draw attention to the complex facilitation work that parents need to engage in when supporting their children's experiences with a tablet, and suggest that providing direct experiential support for facilitation might promote successful family experiences.

2. BACKGROUND

CITE occupies a 36,000 m2 site, part of a larger complex on the edge of Toulouse. Much of this is taken up with 'permanent' exhibits, many of which are large and impressive and hence positioned outside – including a full-scale model of the Ariane 5 launcher currently used by the European Space Agency [Fig 1]. There is 2000m² of indoor exhibition space, incorporating smaller or more interactive exhibitions, and also an IMAX cinema and various shops and cafes. Studies conducted by CITE indicate that the average duration of a visit is 6 hours, principally due to the site's scale and location outside of the city. To complement the permanent exhibits, CITE regularly produces "temporary exhibitions" which are typically left in place for a year. One tactic frequently used in the design of temporary exhibitions is the authoring of alternative narratives that repurpose existing exhibits in interesting ways. These narratives might be communicated through relatively ephemeral media such as leaflets, and might be accompanied by small-scale bespoke exhibits [e.g. see Cité de l'Espace 2010].

Figure 1 Outdoor space at CITE. Left: site from above. Right: Parterre des Planètes (foreground) and Ariane 5 (background). Images courtesy of Cité de l'Espace.

2.1 General design strategy underpinning the tablet experience

The over-arching strategy adopted in the design of the app used in our study was to use an iPad to present fictional narratives that integrated across multiple existing exhibits. This approach was in keeping with existing CITE strategies around the design of temporary exhibitions identified above. It was also driven by a desire on the part of CITE to link together some of the larger outdoor exhibitions into a more cohesive experience - during the design process, museum staff noted that these are drawn from different eras of space exploration, and can feel somewhat disparate. Tablets were chosen for their greater screen-estate, and hence for their capacity to deliver a rich and immersive museum experience to a family group. Prior research suggests that a proportion of museum visitors are willing to bring their own tablet to a museum [V&A 2012], and CITE are also exploring a model of loaning tablets to families for the duration of their visit so as to support access.

2.2 Relevant features of the narrative and application design

For the purposes of this evaluation, we authored two distinctive fictional narratives, working closely with staff at CITE to ensure an appropriate fit to the environment. These were presented through a mixture of digital media, including text, photographs, video, sound and digital games (the latter specifically authored by members of the CHESS project). Digital media can be costly to produce, and Hamma [2005] has identified the economic and museological benefits to museums of re-using media across multiple digital projects. In assembling narratives, we therefore chose to adopt a tactic of integrating, as much as possible, existing digital assets already in the possession of CITE. Observational work conducted earlier in the project had suggested that children tended to "lead" the visiting experience at CITE, with parents acting as facilitators; we therefore chose to primarily target the design of narratives at children. Working from prior internal research conducted by the CITE to quantify its visitor base, we identified the following narratives and age ranges to effectively span the visitor base:

- *The Secret Diary of Philippe Perrin*. [10-16]. Presents a fictional story of a mission to the International Space Station (ISS), from the perspective of an astronaut called Philippe Perrin.
- *Support a Reporter from the year 5000AD*. [5-12]. Asks the user to imagine themselves as a helper for a robot reporter from the future who needed information about space technology.

Selected screens from *The Secret Diary* are presented in Fig. 2 to illustrate the style of this experience. An ambition of our design work was to support engagement by families with multiple children, of varying ages and using a diversity of mobile devices during their visit. This raised the possibility of family members engaging with both narratives concurrently. To avoid creating a perverse incentive for families to split up during their visit, our chosen tactic was to build narratives around a set of five shared locations (Table 1), so that different family members could interact with different material but at the same exhibit. To facilitate a choice between the two narratives, we also provided an interface that delivered a brief summary of key features (Fig 3). Additional material outside of the two core narratives was provided at some locations, and targeted at adult family members. An example was digital video presenting the story of the discovery of Pluto, which could be accessed by visitors to the Parterre des Planètes. *Support a Reporter* concludes with a quiz testing what the user had learned, and presents the user with a digital magazine article integrating photographs they have taken.

Table 1 Selected locations and their primary purpose in the two selected narratives

DESCRIPTION OF LOCATION	ROLE IN "SECRET DIARY"	ROLE IN "SUPPORT A REPORTER"
The museum entrance hall, a large indoor space where tickets are bought.	Philippe introduces himself and his mission to fly to the ISS.	XT555 introduces himself, and tells the user that he will set them a series of missions to help him compile his news story.
The Parterre des Planètes, a scale model of the solar system (Fig. 1)	Philippe discusses the tiny scale of his journey in relation to the size of the solar system.	The user is asked to photograph the Parterre for the news story, and to learn some basic facts about space travel.
The Ariane 5, a full-scale model of a working launch vehicle (Fig. 1).	Philippe shares his personal fears whilst travelling to the ISS	The user is asked to collect information about how the rocket was used as a "primitive" form of space travel.
A Soyuz capsule, surrounded by photographs of re-entry to Earth.	Philippe talks about the visceral experience of returning from space.	The user is asked to collect information about the dangers of returning from space.
The Mir space station, a replica of the original with internal access (Fig. 7).	Philippe shares some fascinating details of his life on board the ISS.	The user is asked to learn about the various tasks that astronauts on space stations do, and to collect photographs showing these.

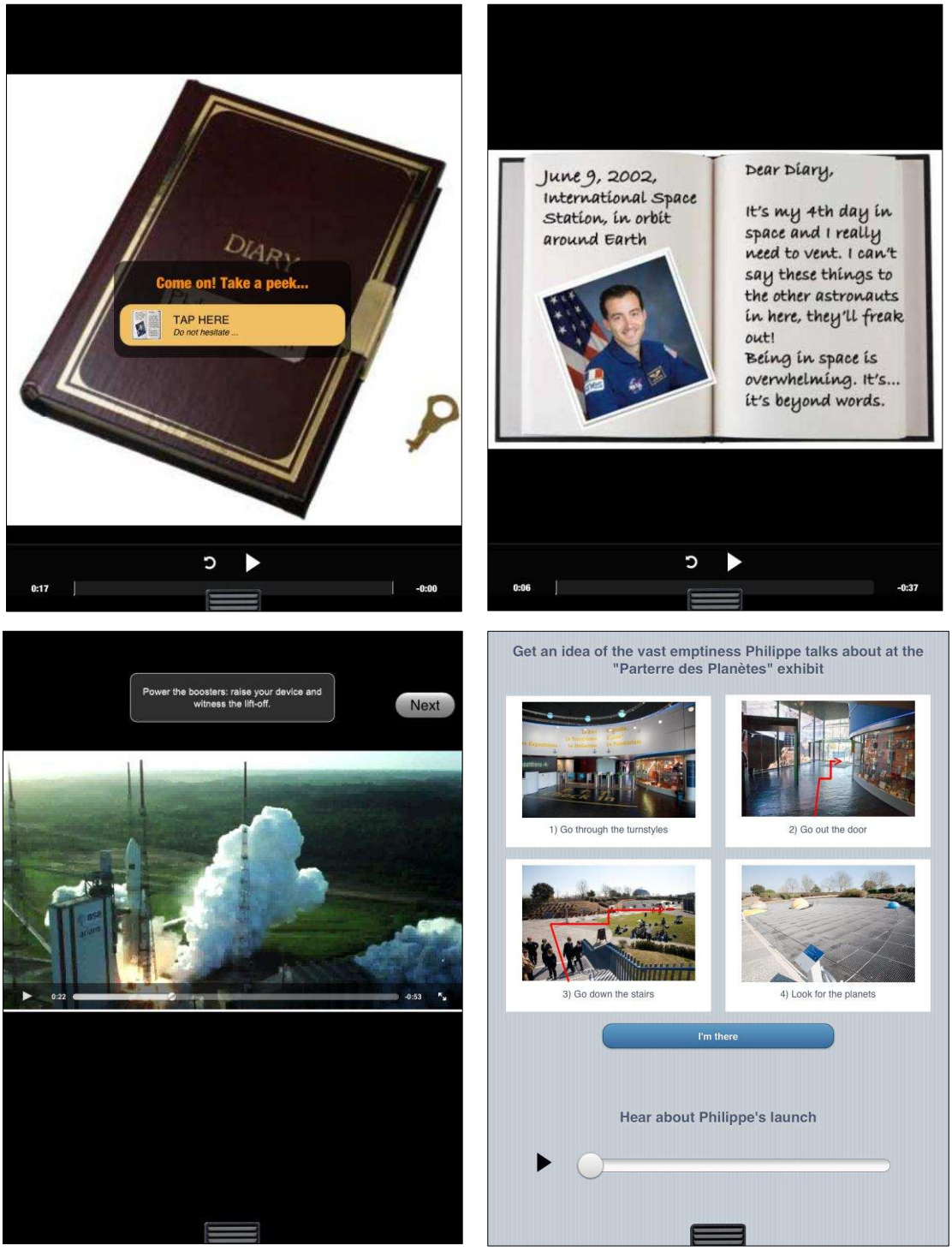

Figure 2 Selected screens from the "Secret Diary".
Clockwise from top left: 1. Opening screen. 2. Diary entry. 3. Video of Ariane 5 launch. 4. Navigation screen.
4: shows photo-based navigation to support movements around the site (further details in [Rennick-Egglestone et al, 2013]).

Figure 3 Choosing a story

2.3 Structure of the evaluation

For the purpose of this evaluation, eight families were recruited through a pre-existing "Friends of Cité de l'Espace" mailing list, and were provided with free entry to the site for the day. Each was allocated a time slot to meet with researchers, and two families who already knew each other were merged into a single group, allowing us to study the behavior and interactions of a larger social unit. In recruiting families and structuring groups (Table 2), our intention was to represent a reasonable cross-section of what might typically be found on a museum visit. On arrival at the entrance hall, each group was allocated a total of either one or two iPads, as selected by the researchers. This was a deliberate choice to facilitate the exploration of subsequent differences in behavior.

Table I. Composition of recruited families

GROUP NUMBER	ADULTS PRESENT	AGE AND GENDER OF CHILDREN	NUMBER OF TABLETS
1	Mother	Nine (M)	Two
2	Mother and grandmother	Six (F), Nine (M)	Two
3	Mother and father	Seven (F), Eight (M)	Two
4	Mother and father	Eight (M), Sixteen (M)	Two
5	Mother and father	Four (F), Nine (F)	One
6 **	Two mothers	Seven (F), Nine (F), Nine (F), Eleven (M)	Two
7	Mother and father	Eleven (M), Thirteen (M)	One

** Group 6 was composed of two families. Tablet count was decided by researchers.

The analytical orientation and conduct of our evaluation has been informed by ethnomethodologically-informed ethnography, which typically uses observations and interviews to document the work that is done by participants in a particular setting, and which has a long tradition of use in the study and design of technologies [Crabtree, Rouncefield and Tolmie 2010]. In our evaluation we principally focused on the work that was done by groups to manage and engage with the tablet experience and the site, and we also documented the impact on other visitors. To allow for observations that were relatively naturalistic, no time limit was given for the engagements, and families were discretely video-recorded from a distance by the researchers, with conversations being captured through lapel microphones. Engagement typically lasted for an hour, and, towards the end of the day, family members returned for a short interview used to clarify our observations.

3. PRINCIPAL FINDINGS

Following the engagement described above, we aggregated recorded video, audio, field notes and interviews, and used this material to produce a set of *thick descriptions* which collectively documented interactions relevant to an understanding of the technology, in keeping with principles outlined by Geertz [1977]. Through a detailed consideration of these, we identified the following key contributions:

- A set of four specific models describing family management behaviors in relation to the tablet
- A record of key activities taking place as part of the work of facilitation

These contributions are illustrated below with examples of specific behaviors drawn from our evaluation. To contextualize our results, we also present specific observations about the impact of the app on other visitors and consider the impact of the site on the experience of using the tablet app.

3.1 Specific models for the management of the tablet

The following behaviors provide a record of how family members collectively shared and interacted with their devices. Presented models should not necessarily be seen as static. Instead, families sometimes transitioned between different models during their engagement. Benford et al [2009] have argued that points of transitions are of interest in a technology design context. As such, descriptions of selected transitions are included directly in the text to aid an understanding of technology use.

Management model one: child leading interaction, adult as facilitator for interaction

This model was most strongly present in those families where at least one tablet per child was available, as these were the families where no child could be excluded from being a primary user through the actions of another child. A typical example of interaction within this model is shown in Fig 4 (left), which shows group 4, a family with two children who had been given two tablets to share. Here, family members essentially split into two pairs as soon as they left the entrance hall, with each pair consisting of a child and a parent who worked to support their engagement (details below).

In the case of group four, the composition of pairs remained remarkably consistent throughout the duration of the experience, but this was not true in all groups, where pairings sometimes changed in the transition between exhibits. Parents often carried tablets during the transition between exhibits, especially in the case of younger children, but then immediately handed them back to children on arrival at a new exhibit, and worked to help them use the tablet. Interview material suggests that the "pairings" observed in our study were a common part of prior museum visits (i.e. they were not purely a product of the presence of a technology). Instead, they might be seen as a family tactic that allowed parents to adapt to the sometimes widely varied needs of children of different ages.

Figure 4 Adults facilitating the work of specific children.

In groups where adults paired with specific children, a distance of several hundred metres sometimes developed between the pairs, which was frequently the result of a younger child working through a narrative at a slower rate. We observed pairs meeting up occasionally during the experience, and hence behaving as a larger family group for a period. This was sometimes occasioned by a lengthy interaction at a specific exhibit (e.g. at Ariane 5, where both authored narratives included both video of a real rocket launch and an interactive game). It was occasionally a deliberate act to share interesting media. In most cases, these larger family groups then rapidly split into pairs again, albeit potentially with a different pairing to the one present before the meeting.

Management model two: Adult as primary user

In groups where there was only one tablet available in total, and especially in a larger family, there were occasions where an adult retained control of the device throughout much of the visit. This was especially visible in group seven, where the father acted as the primary user. Frequently, the father would find an interesting piece of content, and call his children and partner over to see it, which required the family to huddle around the tablet (Fig. 5). When not huddled in this way, other family members clearly stayed within line-of-sight of the father, and typically spent the remainder of their time exploring the exhibits without reference to the tablet. Much of the information passed on by the father was found in the supplementary material to the core narrative, as described at the end of section 2.2. In this instance, this meant that the father effectively acted to craft a new narrative around the material that was presented, rather than relying on the provided narratives to structure the engagement. This allowed him to insert some of his own knowledge as an aerospace expert.

Figure 5 Huddling around a tablet being held by the father

Management model three: Independent usage of tablets by family members

In group one, both mother and child had a tablet, and both chose different narratives at the start of their experience. The two rapidly separated as soon as they entered the site. The child then spent several minutes working through the narrative whilst sitting on a step, rather than "checking in" at the relevant exhibits as intended by the designers. The mother was unaware of this, and worked through a proportion of her chosen narrative. Once the mother became aware that her child was struggling to engage, she returned to help, and tried to transition into a facilitation role (c.f. model 1). However, because she was unaware of which elements he had already explored, and because he had chosen a different narrative to hers, then she was uncertain what he had missed. Without this prior information, she then struggled to help him understand what particular screens in the narrative meant, so could not effectively act as a facilitator until the experience was restarted.

Management model four: Direct collaboration between children

Group six was composed of two families who already knew each other, and contained four children, all of a similar age. In this group, all four children worked together, and managed the tablet themselves, with the two parents having little involvement, and often staying a substantial distance away from the children. Interview and observational material indicates that a primary concern of the children was to work through the same narrative together, at the same rate, on two devices. To facilitate this, they were frequently observed standing close to each other, working to synchronize their navigation through the application by pushing buttons at a similar time. When they occasionally split up and then rejoined, we observed frustration, caused by a need to search through multiple navigation screens in order to synchronize their experience. For group six, the technology seemed to work most successfully in the Mir, where QR codes were used to control access to video. In this context, these codes served as a physical co-ordination point for group efforts to synchronize their experience.

3.2 Facilitation work done by adults and older children

Older members of a family frequently acted as facilitators for younger children, and specific examples highlighting selected elements of the work of facilitation are provided below. Facilitation work done by adults in relation to traditional exhibits has been discussed in prior museums literature (e.g. [Brown 2009]), and our observations suggests that tablets add an additional and distinctive challenge for facilitators. As such, the nature of facilitation work seems important to understand in a technology design context, as technology might conceivably embed features to support facilitation work directly.

Facilitation through physically supporting the tablet

For the youngest children, aged four to seven, facilitation work generally included an adult taking the weight of the tablet during periods of concentrated interaction, as children found it too difficult to hold the tablet and interact with it at the same time. An example of this work can be seen in Fig 4 (left). Some form of physical support typically necessary with children under the age of ten. As noted above, adults sometimes carried the tablet between exhibits, especially for younger children.

Facilitation through teaching about technology

Interview material suggests that younger children often found it hard to understand the specific connection between narrative content and exhibits, and adults often worked to explain important linkages to them. Older children, and especially those over the age of ten, seemed to have little difficulty in understanding this. For these older children, the work of facilitation focused on discussing content to scaffold a greater depth of understanding. In the Mir space station, facilitators sometimes had to explain the purpose of QR codes which were used to provide access to video. In group four, the sixteen year old was observed supporting the experience of the eight year old, suggesting that a division between adults and children would be a false dichotomy.

Facilitation as an activity that challenges the knowledge of the elders

A game in which the user had to match flags painted onto the side of the Ariane 5 to the country of origin of the flag (fig. 6, following page) consistently required parental facilitation, as younger children lacked the knowledge and physical dexterity required to complete the task, and older children failed to fully understand its purpose in relation to the broader narratives that they were being presented with. Adults frequently asked to skip this activity, but children universally wanted to complete it. Post-experience interviews revealed that adults' requests to skip were caused by embarrassment about either their lack of knowledge of European flags or their ability to use the tablet effectively. This was described as being distinctively uncomfortable by some parents.

Figure 6 Game present at the Ariane 5 exhibit

3.3 Impact of the family experience on others visitors

The presence of a tablet changes the behaviour of families, and can therefore have an impact on other visitors. During our study, this was particularly observable in relation to the Mir, which is raised above the ground on metal stilts, and which only has a small interior space for visitors to pass through (fig. 7, left). Content deployed in the Mir consisted of four QR codes, positioned in a narrow space (fig. 7, right), and linked to videos showing cosmonauts working inside the real Mir. Interviews and observations suggest that this was the most effective component of the entire experience for our participants, with family members congregating around tablets to watch videos. However, the additional material slowed progress through the exhibit and created an impedance for other visitors who were queuing to enter. Large queues regularly formed outside. Members of the queue were heard discussing the use of the tablet, though these discussions appeared to be friendly and relaxed. However, our evaluation took place in the autumn, when the site was relatively empty; the impact on others would arguably have been more severe in the summer when the site is closer to capacity.

Figure 7 Left. Narrow entrance to the Mir. Right: Watching video inside the MIR.

3.4 Influence of the site on the family experience

Toulouse typically experiences bright and direct sunshine, even in the autumn. We often observed families searching for shade to support their interaction, or huddling very close together around the tablet so as to block out the sun. There were also locations with a substantial amount of background noise, including ambient music played through outdoor speakers, and spaces where larger crowds of visitors gathered. At times, this made it difficult for visitors to hear audio narratives, and we observed visitors huddling close together, and replaying audio where necessary.

4. BROADER PRINCIPLES FOR TECHNOLOGY DESIGN

The previous section has presented observations drawn from our evaluation work at CITE. These have been structured into a set of findings which might, by themselves, support a broader understanding of how to design mobile museum applications for use by families. We now conclude this paper by identifying three design principles which are grounded in these findings, and presented with the intention of motivating specific approaches to the design of digital experiences for family visiting.

Principle 1: Design for repeated engagement and disengagement

Across the entire study, repeated engagement and disengagement with the tablet on the part of family members was a normal part of interaction. It was observed in the transition between exhibits, where adults frequently took the tablet from children and then handed it back on arrival at the next exhibit. It was observed in families where a single adult led the experience, and where other family members then engaged and disengaged repeatedly. Occasionally, a parent would also try and engage part way through an experience – perhaps to help out a child who was struggling. Though not seen in our study, we might also expect disengagement caused by breaks for toilet stops or for food, especially in the context of an experience designed for use throughout an entire day of visiting. The ubiquitous nature of engagement and disengagement during a museum visit raises a question of how to design experiences that are robust in light of this phenomenon, and whether engagement and disengagement can be seen as opportunities for interaction design. It also differentiates group visiting from experiences in which engagement and disengagement are less common, such as a trip to the cinema.

A clear consequence of the above is that family members are unlikely to have a complete view of the history of interactions with an app during a visit. Instead, each member may only have a partial view, acquired during a period of engagement, and potentially excluding important details. This observation potentially argues against the design of all-encompassing narratives which assume constant engagement, and which are essentially linear in nature. Instead, it suggests the design of narratives composed of fragments, which can be sporadically engaged with, to support the visiting patterns of a family. This does not preclude the design of narratives which integrate across multiple exhibits (as was the case for the app featured in this evaluation) but it does argue for creating space for flexibility in interaction by avoiding excessive dependencies between materials presented at different exhibits. It also does not preclude a family or group wishing to work through an experience together - some may wish to do this, but technology design may need to allow family member to easily “catch up” with the experience where important elements have been missed.

Designing facilities to support this becomes particularly challenging when multiple devices are used to access an app – in this context, observations of group six, presented earlier, have identified the need to support experiential co-ordination, e.g. members of a family group working together to bring two tablets to the same screen so as to navigate it together for a period. A desire for experiential co-ordination has also been noted by Fosh et al [2013], who studied couples engaging with a digital experience situated in a sculpture garden. How best to provide support for this is an open question.

Principle 2: Design to support facilitation work

A substantial body of prior work has documented the work that parents typically do to assist children in engaging with traditional exhibits (e.g. Brown [2009], who studied family engagement with science centers). Our study suggests that the presence of the tablet implicates a range of complex skills and knowledge that go beyond traditional facilitation work, and which additionally encompass:

- specific knowledge of how to use the tablet and the app
- general knowledge about material presented in the app, and the exhibits that it links to
- knowledge of interactions that have taken place on the part of children, earlier in the visit

These additions potentially make facilitation of engagement with tablets a more complex endeavor. Material presented in the findings section illustrates some of the uncomfortable interactions that can result if facilitators are lacking in any of these elements, and these might then be detrimental in relation to engagements with technology. This then raises a question of how to scaffold the development of skills and knowledge without having an excessively negative impact on the visiting experience of the facilitator, which implicates a careful consideration of where in the larger trajectory of experience to situation the scaffolding process.

In this context, support for family facilitation work might implicate carefully-designed interactions allowing adults to discretely and easily monitor the progress of children without imposing excessive burdens on them. These kinds of interaction have been explored in prior work around "eavesdropping" as an interaction mechanism in a museum audio guide [Aoki et al 2002]. Here, Grinter et al specifically noted the value of eavesdropping in allowing couples to keep track of each other's statuses.

Principle 1 then hints at the potential of designing around periods of disengagement (on the part of children). As an example, we might consider the journey from one exhibit to another as being an opportunity to discretely pass on information to an adult through the medium of the tablet, to support them in the work of facilitating engagement at the next exhibit. This journey might also provide an opportunity for parents to review what activities the child has engaged in at the previous exhibit.

Principle 3: Design for effective integration with the site

Observations at the Mir space station highlighted the disruption caused by encouraging a significant number of family members to group together in a narrow space. These observations can be situated in a larger debate about the impact on the museum visiting experience of mobile device usage (e.g. see coverage of this in relation to the National Portrait Gallery in London [Furness 2014]). We have also noted the impact on the users of site-specific considerations at CITE, including bright sun and situated audio, and noted how they encouraged family members to huddle together around the tablet. More generally, we might note the crucial important of considering the affordances and constraints of the site when designing experiences targeted at families. We can infer from this that effective design may require tools that are aware of the unique nature of family engagement, and which allow designers to identify effective strategies for delivering content, which optimize as much as possible the experience for all, including those that have chosen not to engage with technology.

5. CONCLUSIONS

We have presented a specific set of observations from the deployment of a bespoke tablet experience at Cité de l'Espace, a space science centre. Analytical work has highlighted some distinctive patterns of family behavior which could be accounted for in technology design work. We have discussed the need for experience designers to account for repeated engagement and disengagement with technology, and highlighted the need to support the work of family members acting as facilitators.

More broadly, our observations draw attention to a substantial variation in management and visiting behaviours, suggesting the need for a flexible experience design which avoids imposing a rigid interactional model on families. Essentially, we would argue that a family needs to be able to shape their technology usage around a visit, rather than having an experience design imposed on them.

Finally, we note that highlighted phenomena are strongly linked to relationships between adults and children (e.g. in facilitation work) or children and children (e.g. groups of children co-ordinating their experiences). As such, we would suggest that designing museum experiences for families with non-adult children does require a distinctive focus, and should remain an active field of research.

6. ACKNOWLEDGEMENTS

This work has been supported by the CHESS project (European Commission project number 270198) and by the "Living with Digital Ubiquity" platform grant (EPSRC reference EP/M000877/1). The authors gratefully acknowledge the support received for this work through these grants.

REFERENCES

Paul Aoki, Rebecca Grinter, Amy Hurst, Margaret Szymanski, James Thornton, and Allison Woodruff. 2002. Sotto voce: exploring the interplay of conversation and mobile audio spaces. In *Proceedings of CHI '02*.

Kikuo Asai, Yugi Sugimoto and Mark Billinghurst. 2010. Exhibition of lunar surface navigation system facilitating collaboration between children and parents in science museum. In *Proceedings of VRCAI 2010*.

Steve Benford, Gabriella Giannachi, Boriana Koleva and Tom Rodden. From interaction to trajectories: designing coherent journeys through user experiences. In *Proceedings of CHI 2009*.

Cynthia Cone and Keith Kendall. 1978. Space, Time, and Family Interaction: Visitor Behavior at the Science Museum of Minnesota. Curator: The Museum Journal. 21, 3, 245–258

Andrew Crabtree, Mark Rouncefield and Peter Tolmie. 2010. Doing design ethnography. London, UK: Springer Verlag.

Kirsten Ellenbogen. 2002. Museums in family life: An ethnographic case study. Learning conversations in museums, 81-101.

Cité de l'Espace. 2010. EXTRATERRESTRIALS LAND IN TOULOUSE! http://en.cite-espace.com/space-news/extraterrestrials-land-in-toulouse/ . Verified 16th November 2015.

John Falk. 2009. Identity and the museum visitor experience. Walnut Creek, CA: Left Coast Press Inc.

Lesley Fosh, Steve Benford, Stuart Reeves, Boriana Koleva and Patrick Brundell. 2013. 'See Me, Feel Me, Touch Me, Hear Me': Trajectories and Interpretation in a Sculpture Garden. In *Proceedings of CHI 2013*.

Hannah Furness. 2014. National Gallery relents over mobile phones. Daily Telegraph. 12th August 2014. http://www.telegraph.co.uk/culture/art/art-news/11028015/National-Gallery-relents-over-mobile-phones.html

Clifford Geertz. 1977. The Interpretation of Cultures. Basic Books.

Rebecca Grinter, Paul Aoki, Amy Hurst, Margaret Szymanski, James Thornton, and Allison Woodruff. 2002. Revisiting the Visit: Understanding How Technology Can Shape the Museum Visit. Proc. CSCW 2002.

Ken Hamma. 2005. Becoming Digital. Bulletin of the American Society for Information Science and Technology. 30, 5, 11–13.

Stefan Rennick-Egglestone, Maria Roussou, Pat Brundell, Christophe Chaffardon, Vasilis Kourtis, Boriana Koleva, and Steve Benford. Indoors and outdoors: designing mobile experiences for Cité de l'Espace. In *Proceedings of NODEM 2013*.

Nina Simon. 2010. Where's the mobile museums project for intact social groups? http://museumtwo.blogspot.gr/2010/04/wheres-mobile-museum-project-for-intact.html

Peter Tolmie, Steve Benford, Chris Greenhalgh, Tom Rodden and Stuart Reeves. 2013. Supporting group interactions in museum visiting. In *Proceedings of CSCW 2013*

Victoria and Albert Museum. Understanding the Mobile V&A Visitor. Autumn 2012. Technical report published by institution. http://www.vam.ac.uk/__data/assets/pdf_file/0009/236439/Visitor_Use_Mobile_Devices.pdf. Verified 30th November 2015.